PATENT SPECIFICATION

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DRAWINGS ATTACHED

Inventor:- ROBERT JACK SMITH-GORMAN

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COMPLETE SPECIFICATION

Improvements in or relating to Tumbling Apparatus

We, ROLLS-ROYCE LIMITED, a British Company, of Nightingale Road, Derby, in the County of Derby, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to tumbling apparatus, that is, apparatus comprising a container in which articles are placed together with chips of granite or like material and water, kerosene, or oil, containing a suspension of an abrasive compound, the container being then rotated so that the articles tumble and are deburred and polished by the abrasive.

According to the present invention in one aspect there is provided a method of deburring or polishing metal parts which method comprises the steps of feeding the parts into one, inlet, end of a tube containing a suspension of abrasive in a liquid and rotating about a longitudinal axis which is at a substantial angle to the vertical, causing the parts to travel continuously from the inlet end to the opposite, outlet, end of the tube by means of the rotation of the tube, and receiving the parts issuing from the outlet end of the tube.

According to the present invention in another aspect there is provided tumbling apparatus in which metal parts are deburred or polished by tumbling in a suspension of abrasive in a liquid, comprising a rotatable tube into one, inlet, end of which the metal parts are fed, said tube being constructed or arranged so that by rotation of the tube the metal parts are caused to travel continuously from the inlet end to the opposite, outlet end, and means to receive the parts issuing from the outlet end of the tube. The tube may be horizontal and have an internal helical thread, or may be inclined with its inlet end uppermost, or may be both inclined and have a helical thread, for the purpose of causing travel of the articles on rotation of the tube. In one preferred arrangement the tubes are tapered from their outlet ends to their inlet ends, so as to be, for example, of frusto-conical form, and are provided with an internal helical thread, which is deep and of coarse pitch adjacent the inlets of the tubes graduating to a finer thread of less depth adjacent the outlets of the tubes.

According to an important feature of the invention, the tube may be lined internally with abrasive-resistant material and the helical thread, where provided, is formed on the radially-inner surface of the lining.

According to another important feature of the invention the tube may be provided internally with baffle means constructed and arranged to reduce the rate of continuous flow of articles through the tube. The baffle means may comprise one or more baffle plates which block movement of the articles lengthwise of the tube except through a notch which is formed at the periphery of each plate.

According to another feature of the invention a plurality of such tubes may be provided, the tubes being arranged to be traversed by the articles in succession by the provision of transfer means between the outlet end of one tube and the inlet end of the next tube. The articles may be passed through each of the tubes, or provision may be made for the insertion of articles at an intermediate point in the train of tubes so that articles requiring different

processing times can be dealt with at the same time.

According to another feature of the invention there is provided for use with tumbling apparatus a screening unit comprising a rotatable screening tube provided with screening apertures, said screening tube being constructed or arranged so that, on rotation of the tube articles fed into one, inlet, end of the screening tube are caused to travel towards its opposite, outlet, end.

In a preferred arrangement according to this aspect of the invention, a plurality of such screening tubes are provided through which those articles not falling through the screening apertures pass in succession, there being provided transfer means for the articles from the outlet end of one screening tube to the inlet of the next. In this preferred arrangement the screening tubes are of wire mesh coated with an abrasive-resistant material, and a helical thread or beading made of abrasive-resistant material is bonded thereto internally of the tube.

Some embodiments of tumbling apparatus according to this invention will now be described by way of example. The description makes reference to the diagrammatic drawings accompanying the provisional specification of Application No. 18192/56 in which:

Figure 1 shows the general arrangement of one embodiment;

Figure 2 shows one arrangement of the tumbler tubes;

Figure 3 shows the general arrangement of a suitable screening unit;

Figure 4 is a section through one form of tumbler tube;

Figure 5 is a section through a second form of tumbler tube, and

Figure 6 is a sectional view of part of one form of screening tube,

and to the diagrammatic drawings accompanying the provisional specification of Application No. 39719/56 in which:

Figure 1 shows a perspective view of the general arrangement of a tube fitted with baffle plates with parts of the tube broken away to show the plates,

Figure 2 shows an axial section through the tube,

Figure 3 shows a baffle plate, and

Figure 4 illustrates a modification of the arrangement of screening tubes.

Referring first to the drawings accompanying the Provisional Specification of Application No. 18192/56, the apparatus shown in Figures 1 to 4 comprises two stacks 10 of rotatable tubes 11 through which the articles together with chips of granite or other suitable material pass in succession, the articles being transferred from one stack 10 to the next by an elevator 12. After processing in the stacks of tubes 11, the articles and chips are transferred by a second elevator 12 to a screening unit 13 for separation. The stacks 10 of tubes, the elevators 12 and the screening unit 13 are all immersed in a tank 14 containing a suspension of abrasive compound in kerosene, oil or corrosion-inhibited water.

Each stack 10 of tubes comprises a number of tubes 11 arranged horizontally, alternate tubes being offset laterally to one side of the vertical centre line of the stack, and the remaining tubes being offset to the other side of the centre line of the stack. In an alternative arrangement, the tubes may be inclined to the vertical with the inlet ends uppermost.

The tubes 11 are provided internally with a lining 11a of an abrasive-resistant material, such as rubber or polyvinyl chloride, and a coarse thread 15 is moulded on this lining. Conveniently the linings 11a of the tubes have all a right-hand thread or have all a left-hand thread, and each tube is driven in the opposite direction to the next adjacent tube or tubes. External flanges may be provided adjacent the ends of the tubes for mounting purposes, and a central flange on each tube may be provided for transmission of the drive.

Chips of a selected size, or selected sizes, and articles fed into the appropriate end of the top tube of the first stack 10 are tumbled and moved continuously along the tube by the thread 15. A fixed chute 16 is provided at the outlet end of the first tube so that the articles are guided into the adjacent inlet end of the next lower tube, and since the latter has an identical thread but is rotated in the opposite direction to the first tube, the articles are then moved along the second tube. A similar chute 16 is provided at the outlet end of each tube 11 connecting it with the inlet end of the next tube of the stack, so that the articles follow a sinuous path through the stack. On emerging from the bottom tube of the stack, the articles are lifted to the top of a second and similar stack 10 by a worm-type elevator 12.

The worm-type elevator 12 comprises a worm element 12a rotating in a vertical cylindrical casing 12b, and the operating surfaces of the element and the casing are coated with abrasive-resistant material.

On discharge from the bottom tube of the second stack 10 the articles are conveyed to the screening unit 13 for separation of the chips and articles. Where articles of different sizes and chips of different sizes have been passed through the tubes 11 together the screening unit 13 serves to separate them into their size groups again.

One preferred arrangement of screening unit shown diagrammatically in Figure 3 comprises four horizontal screening tubes 17 which are formed from mild steel wire mesh coated with rubber or other abrasive-resistant material. A helical beading or thread is bonded to the inside of the tubes, so that on rotation of the screening tubes about their longitudinal axes the mingled articles and chips are carried through the tubes 17 or fall through the mesh on to chutes, down which the separated articles or chips slide to a respective elevator 18 or 19, for example a worm-type elevator as previously described, for conveyance to a delivery chute. Chips which are separated out are returned to the inlet of the first stack of tubes 11 for recirculation through the machine with the incoming articles.

The articles and chips which are carried through one screening tube 17 are delivered into the next screening tube 17 down a fixed chute 20 for further separation. The first two screening tubes may be of one mesh size and the last two screening tubes may be of a second mesh size. This screening unit is intended to deal with articles of one size and chips of two sizes, or with articles of two sizes and chips of one size. Generally, all the chips will be returned to the inlet to the first stack of tubes 11 by the same conveyor, and a separate delivery conveyor will be provided for each size of article.

The separation is assisted by vibrating the screening tubes, and to this end the screening unit comprises a vibrator 21, which is preferably of the electromagnetic alternating-current contactless type.

In an alternative arrangement shown in Figure 6, the screening tubes 17 are formed from cylinders lined internally with abrasive-resistant material, and a coarse thread 17a is formed on the radially inner surface of the lining. The screening apertures 17b are provided in the base of the helical channel of the thread.

In the above arrangements the screening unit 13 forms a self-contained unit which is mounted to be readily interchangeable with other screening units of a potential screening range within the general capacity of the machine.

The tank 14 in which the tubes, elevators and screening unit are housed is provided with a water float valve 24 of the normal ball and valve type to control the intake from the mains water supply, and there is provided a hopper 25 containing abrasive compound which is operated by time-cycle solenoid-operated device 26 to discharge additional abrasive compound into the tank at pre-set intervals of time. A water-change valve 27 of the time-cycle solenoid-operated type is also provided to drain off all the water at pre-set time intervals and to allow the water float valve 24 to refill the tank 14 with fresh water and the hopper 25 to recharge the tank with abrasive compound. A circulating pump 28, which is preferably of the self-priming diaphragm type, maintains the water in circulation and prevents settling-out of the abrasive compound. The hopper 25 may be arranged to charge a fresh supply of abrasive compound into the tank with each charge of parts to be processed.

Inlets to the train of tubes contained in a stack may be provided at different points in the train so that the machine can deal with articles requiring different processing times, say by reason of the finish required, at one and the same time.

Figure 5 illustrates diagrammatically another preferred arrangement, in which the tumbler tubes 11 are of tapering form from their outlets to their inlets, and are rotated about a horizontal axis. The tubes are provided internally with an abrasive-resistant liner as in the previously described construction, so that the articles are passed along the tube by the thread assisted by a measure of gravitation, but the helical thread, instead of being uniform is coarse and deep adjacent the inlet (smaller diameter) end graduating to a finer, shallower thread adjacent the outlet (larger diameter) end. In one construction, for example, the tubes have a taper of 1 in 40, and the thread has a pitch of 1 inch and a depth of ¼ inch at the inlet end, and has a pitch of 1/5th inch and a depth of 1/8th inch at the outlet end of the tube. This arrangement ensures that the entrance to each tube is cleared quickly, and that in the event of overloading of the tubes the articles can ride over the thread.

Instead of being immersed in a bath containing a suspension of abrasive material in water, kerosene, or oil, the

tubes may be fed with the suspension through a spray 22 located in the inlet to the top tube of each stack, and in this case seals are provided between each tube 11 and the co-operating chute or chutes 16. The suspension may be sprayed into the tube together with each fresh charge of parts to be processed.

The tubes may be made of aluminium sheet and driving and mounting flanges for the tubes may be in the form of aluminium castings. The tubes may be lined with neoprene, polyvinyl chloride, rubber or other suitable abrasive-resistant material.

Alternatively the tumbler tubes and screening tubes may be made, complete with mounting and driving flanges, from wire-reinforced polyester plastic material. The helical thread is in this case formed integrally with the tubes, no lining being required.

Referring now to the drawings accompanying the provisional specification of Application No. 39719/56, in the modified arrangement shown in Figures 1, 2 and 3, the tube of the tumbling apparatus, as before, consists of a frusto-conical tube 110 which tapers in diameter from its outlet 110a to its inlet 110b and is supported in bearings (not shown) for rotation about a horizontal axis. The tube 110 is lined internally with rubber or other abrasive-resistant material.

To prevent the mass from traversing the length of the tube 110 too quickly and thus making necessary a considerable length of tube in order to provide an adequate processing time, a series of baffle plates 111 are fixed in the tube 110 at regular intervals along its length, designed and arranged to impede the longitudinal movement of the traversing mass, but to ensure a consistent flow devoid of the possibilities of lodgement with its associated risk of over-processing. The spacing of the baffle plates 111 from each other is sufficient to allow the articles to take up any position, at a point where successive baffle plates 111 are nearest each other, with a clearance from each of the baffle plates.

Each baffle plate 111 in this arrangement consists of a disc made from aluminium or mild steel coated with rubber or other abrasive-resistant material, and the plane of each disc makes an angle α with an imaginary plane perpendicular to the axis of the tube, the value of α being in the range 10^0-20^0, dependent on the size of the articles and on other factors. The action obtained with this sloping arrangement is that the plates 111 tend to throw back the mass in the upstream direction so that a longer processing time is obtained in each tube. In the case of articles weighing less than about 1 oz. each, it is found that the maximum effective value of α is about 10^0, since, if the angle is higher, articles trapped in the corner between the baffle and tube remain lodged despite the rotation of the tube because the gravitational effect is insufficient in comparison with the centrifugal force to dislodge them. For parts weighing more than 1 oz. the maximum effective value of α is 20^0, any increase beyond this value tending to diminish the throwing-back action.

A notch 112 is formed in the periphery of each plate 111, the notch being sufficiently large to allow the articles to pass through it. The sloping arrangement of each baffle plate 111 is such that the notch 112 is nearest the outlet end of the tube and the parts of the plate diametrically opposite the notch are nearest the inlet end of the tube. The notches of successive baffle plates are displaced from each other by 180^0 of rotation of the tube.

Referring now particularly to Figure 3 it can be seen that the leading edge 112a of each baffle plate, that is, the edge of the baffle plate which parts the flow of articles, is bent over towards the downstream end of the tube to form a lip, the action of which is to tend to deflect back in the upstream articles which impinge on or near this edge, and that the trailing edge 112b is bent over towards the upstream end of the tube to form a lip so that articles contacting the upstream face of the baffle plate are deflected upstream away from the notch 112.

In one example a rubber-lined frusto-conical tube 5 ft. long has an inlet diameter of 6.00" and an outlet diameter of 7.00", and is connected to be rotated at a peripheral speed of 80 ft. per minute about a horizontal axis. Thus the "fall" along the tube is 0.100" per foot length of tube. In this case a loose mass is found to move one foot along the tube in 12 seconds.

The inclusion of a series of specially designed baffles was found to increase the traverse time considerably. Thus, employing 3 baffles in each foot length of tube, the time taken for the mass to traverse a foot length was increased to 6 minutes 12 seconds. The number of baffles employed per foot length of tube depends on the size of the articles. For example, if parts 2" long are to be processed, the baffles

must be 2" plus a clearance allowance apart at their nearest point, and should thus be, say, 3" apart.

One or more baffle plates similar to those described above may, according to a feature of the present invention, be fixed in the screening tubes to reduce the rate of flow through these tubes.

In a modification of the screening arrangement previously described, the screening apertures may take the form of longitudinal slots which run substantially the full length of the screening tubes so that an increased screening area is obtainable. In the arrangement illustrated in Figure 4 of the drawings the width of the slots is adjustable by using two such slotted tubes 117c, 117d one fitting fairly closely inside the other, and is adjusted by rotating the tubes relative to one another, suitable turning and locking devices being provided. Both of the tubes are lined internally with rubber, and the radial clearance between the outer surface of the inner tube 117c and the inner surface of the outer tube 117d is 0.010 in one arrangement in which the inner diameter of the inner tube is 7.5".

Six equally-spaced parallel slots are formed in both tubes, and one edge 116 of the inner tube 117c is turned inwardly to guide the mass to the slot. The rubber covering of the edges of the slots may be such as to provide slots having their axes at an angle, for example 35° to the radial direction. The inturned edge 116 also serves to improve the agitation of the mass.

The outer tube is provided with three peripheral mounting and driving flanges which impart rigidity to the composite tube.

Where the screening tube is provided with baffles as hereinbefore described, the parts of the inner tube 117c may be held together and stiffened by the baffles.

Thus, the tumbling apparatus described provides a completely automatic machine for deburring and polishing articles, which is suitable for remote quality control by closed-circuit television.

WHAT WE CLAIM IS:-

1. A method of deburring or polishing metal parts, which method comprises the steps of feeding the parts into one, inlet, end of a tube containing a suspension of abrasive in a liquid and rotating about a longitudinal axis which is at a substantial angle to the vertical, causing the parts to travel continuously from the inlet end to the opposite, outlet, end of the tube by means of the rotation of the tube, and receiving the parts issuing from the outlet end of the tube.

2. Tumbling apparatus in which metal parts are deburred or polished by tumbling in a suspension of abrasive in a liquid, comprising a rotatable tube into one, inlet, end of which the metal parts are fed, said tube being constructed or arranged so that by rotation of the tube the metal parts are caused to travel continuously from the inlet end to the opposite, outlet, end, and means to receive the parts issuing from the outlet end of the tube.

3. Tumbling apparatus as claimed in Claim 2, wherein the tube is provided internally with a helical thread.

4. Tumbling apparatus as claimed in Claim 3, wherein said thread is deep and of coarse pitch adjacent the inlet end of the tube graduating to a thread having a finer pitch of less depth adjacent the outlet of the tube.

5. Tumbling apparatus as claimed in Claim 3, or Claim 4, wherein the tube is cylindrical and is arranged horizontally.

6. Tumbling apparatus as claimed in Claim 2 or Claim 3, wherein the tube is inclined with its inlet end uppermost.

7. Tumbling apparatus as claimed in Claim 2 or Claim 3, wherein the tube is tapered from its outlet end to its inlet and is arranged with its longitudinal axis of symmetry substantially horizontal.

8. Tumbling apparatus as claimed in any of Claims 2 to 7, wherein the tube is lined internally with abrasive resistant material, and the helical thread, where provided, is formed on the radially-inner surface of the lining.

9. Tumbling apparatus as claimed in any of Claims 2 to 7, wherein the tube is made from wire-reinforced polyester plastic material.

10. Tumbling apparatus as claimed in any of Claims 2 to 9, wherein the tube is provided internally with baffle means constructed and arranged to reduce the rate of continuous flow of articles through the tube without impeding the continuous tumbling action.

11. Tumbling apparatus as claimed in Claim 10, wherein the baffle means comprises one or more baffle plates which block movement of the articles lengthwise of the tube except through a notch which is formed at the periphery of each plate.

12. Tumbling apparatus as claimed in Claim 10, wherein when the tube is

provided with more than one baffle plate the notches of successive baffle plates are displaced angularly from each other.

13. Tumbling apparatus as claimed in Claim 12, wherein successive baffle plates are arranged with their notches displaced from each other by 180° of rotation of the tube.

14. Tumbling apparatus as claimed in any of Claims 11 to 13, wherein the plate or each plate is fixed in the tube with its plane sloping at an angle to an imaginary plane which is perpendicular to the lengthwise axis of the tube, the arrangement being such that the portions of the plate diametrically opposite the notch are nearest the inlet end of the tube, the portions of the plate adjacent the notch being furthest away from the inlet end of the tube.

15. Tumbling apparatus as claimed in Claim 14, wherein said angle is within the range 10°-20°.

16. Tumbling apparatus as claimed in any of Claims 11 to 15, wherein the leading edge of the baffle plate, that is, the edge which parts the flow of articles moving on to the edge under gravity, is bent towards the downstream end of the tube and afford a lip which tends to deflect the articles back in an upstream direction.

17. Tumbling apparatus as claimed in any of Claims 11 to 16, wherein the trailing edge of the notch, that is the edge opposite to that which parts the flow of articles moving on to it under gravity, is bent over in an upstream direction and tends to deflect the articles upstream and away from the notch.

18. Tumbling apparatus as claimed in any of Claims 10 to 17, wherein the baffle means is coated with abrasive-resistant material.

19. Tumbling apparatus as claimed in any of Claims 2 to 18, wherein there is provided a train of tubes arranged to be traversed in succession by the articles, and transfer means between the outlet end of one tube and the inlet end of the next tube.

20. Tumbling apparatus as claimed in Claim 19 wherein the tubes are disposed one above the other in a bank with their longitudinal axes extending horizontally, each tube having its outlet end adjacent the inlet end of the tube next below it.

21. Tumbling apparatus as claimed in any of Claims 2 to 20, comprising also a screening unit comprising a rotatable screening tube provided with screening apertures, said screening tube being constructed or arranged so that, on rotation of the tube articles fed into one, inlet, end of the screening tube are caused to travel towards its opposite, outlet, end.

22. Tumbling apparatus as claimed in Claim 21, wherein the screening tube comprises a cylinder or a frusto-conical tube provided internally with a helical thread.

23. Tumbling apparatus as claimed in Claim 22, wherein the thread is of coarse pitch and the screening apertures are provided in the base of the helical channel of the thread.

24. Tumbling apparatus as claimed in Claim 21 or Claim 22 wherein the screening apertures are afforded by slots which extend axially of the screening tube.

25. Tumbling apparatus as claimed in Claim 24, wherein the screening tube comprises two coaxial tubes fitted closely one within the other, corresponding longitudinal slots being provided in both of the tubes, and the tubes being rotatable relative to one another to adjust the width of the screening apertures, and wherein there is provided means to lock the tubes in their desired position relative to one another.

26. Tumbling apparatus as claimed in Claim 25, wherein the outer of the two coaxial tubes is lined with rubber or other abrasive-resistant material.

27. Tumbling apparatus as claimed in any of Claims 24 to 26, wherein the slots extend at an angle of the order of 35° to the radial direction.

28. Tumbling apparatus as claimed in any of Claims 21 to 27, wherein the screening tube is lined internally with abrasive-resistant material, and the helical thread, where provided, is formed on this lining.

29. Tumbling apparatus as claimed in any of Claims 21 to 27 wherein the screening tube is formed from wire-reinforced polyester plastic.

30. Tumbling apparatus as claimed in Claim 29, wherein the helical thread, where provided, is formed integrally with the tube.

31. Tumbling apparatus as claimed in Claim 21, wherein the screening tube is formed from wire mesh.

32. Tumbling apparatus as claimed in Claim 31, wherein the wire mesh is coated with abrasive resistant material.

33. Tumbling apparatus as claimed in Claim 31 or Claim 32, wherein a helical beading is bonded to the tube internally thereof.

34. Tumbling apparatus as claimed in any of Claims 21 to 33, wherein the screening tube is provided with baffle means as claimed in any of Claims 10 to 18.

35. Tumbling apparatus as claimed in any of Claims 21 to 34 wherein one or more such screening tubes is or are provided as a unit which is mounted to be readily interchangeable with other units having different screening ranges.

36. Tumbling apparatus as claimed in any of Claims 21 to 35, comprising also means to vibrate the screening tube or tubes.

37. Tumbling apparatus as claimed in any of Claims 21 to 36, wherein the processing tubes and screening tubes are housed in a tank containing the liquid in which the abrasive is suspended.

38. Tumbling apparatus as claimed in Claim 37 wherein in operation of the apparatus the abrasive and liquid are changed automatically at pre-set intervals of time.

39. Tumbling apparatus as claimed in any of Claims 2 to 36, wherein a fresh supply of abrasive is charged into the processing tube or tubes with each charge of parts to be processed.

40. Tumbling apparatus as claimed in Claim 38, wherein the suspension of an abrasive in a liquid is sprayed into the processing tube or the first processing tube together with each fresh charge of parts to be processed.

41. Tumbling apparatus substantially as hereinbefore set forth with reference to and as illustrated in the accompanying drawings.

BOULT, WADE & TENNANT,

111 & 112, Hatton Garden,
London, E.C.1.
Chartered Patent Agents

PROVISIONAL SPECIFICATION

No. 18192 A.D. 1956

Improvements in or relating to Tumbling Apparatus

We, ROLLS-ROYCE LIMITED, a British Company, of Nightingale Road, Derby, in the County of Derby, do hereby declare this invention to be described in the following statement:-

This invention relates to tumbling apparatus, that is, to apparatus comprising a container in which articles are placed together with chips of granite or like material and water, kerosene, or oil, containing a suspension of an abrasive compound, the container being then rotated so that the articles tumble and are deburred and polished by the abrasive.

According to the present invention there is provided tumbling apparatus comprising a rotatable tube, means to feed articles to be deburred or polished into one (or inlet) end of the tube, said tube being constructed or arranged so that by rotation of the tube the articles are caused to travel continuously from the inlet end to the opposite (or outlet) end, and means to receive the articles issuing from the outlet end of the tube. The tube may be horizontal and have an internal helical thread, or may be inclined with its inlet end uppermost, or may be both inclined and have a helical thread, for the purpose of causing travel of the articles on rotation of the tube. In one preferred arrangement the tubes are tapered from their outlet ends to their inlet ends, so as to be, for example, of frusto-conical form, and are provided with an internal helical thread, which is deep and of coarse pitch adjacent the inlets of the tubes graduating to a finer thread of less depth adjacent the outlets of the tubes.

According to a feature of the invention, the tube may be lined internally with abrasive-resistant material and the helical thread, where provided, is formed on the radially-inner surface of the lining.

According to another feature of the invention a plurality of such tubes may be provided, the tubes being arranged to be traversed by the articles in succession by the provision of transfer means between the outlet end of one tube and the inlet end of the next tube. The articles may be passed through each of the tubes, or provision may be made for the insertion of articles at an intermediate point in the train of tubes so that articles requiring different processing times can be dealt with at the same time.

According to another aspect of the invention there is provided for use with tumbling apparatus a screening unit comprising a rotatable screening

tube provided with screening apertures, said screening tube being constructed or arranged so that, on rotation of the tube articles fed into one (or inlet) end of the screen tube are caused to travel continuously towards its opposite, or outlet, end.

In a preferred arrangement according to this aspect of the invention, a plurality of such screening tubes are provided through which those articles not falling through the screening apertures pass in succession, there being provided transfer means for the articles from the outlet end of one screening tube to the inlet of the next. In this preferred arrangement the screening tubes are of wire mesh coated with an abrasive-resistant material, and a helical thread or beading made of abrasive resistant material is bonded thereto internally of the tube.

Some embodiments of tumbling apparatus according to this invention will now be described by way of example.

The description makes reference to the accompanying diagrammatic drawings in which:

Figure 1 shows the general arrangement of one embodiment;

Figure 2 shows one arrangement of the tumbler tubes;

Figure 3 shows the general arrangement of suitable screening unit;

Figure 4 is a section through one form of tumbler tube;

Figure 5 is a section through a second form of tumbler tube, and

Figure 6 is a sectional view of part of one form of screening tube.

Referring to Figures 1 to 4 of the drawings, the apparatus comprises two stacks 10 of rotatable tubes 11 through which the articles together with chips of granite or other suitable material pass in succession, the articles being transferred from one stack 10 to the next by an elevator 12. After processing in the stacks of tubes 11, the articles and chips pass to a screening unit 13 for separation. The stacks 10 of tubes, the elevators 12 and the screening unit 13 are all immersed in a tank 14 containing a suspension of abrasive compound in corrosion-inhibited water.

Each stack 10 of tubes comprises a number of tubes 11 arranged horizontally, alternate tubes being offset laterally to one side of the vertical centre line of the stack, and the remaining tubes being offset to the other side of the centre line of the stack.

The tubes 11 are provided internally with a lining 11a of an abrasive-resistant material, such as rubber or polyvinyl chloride, and a coarse thread 15 is moulded on this lining. Conveniently the linings 11a of the tubes have all a right-hand thread or have all a left-hand thread, and each tube is driven in the opposite direction to the next adjacent tube or tubes. External flanges may be provided adjacent the ends of the tubes for mounting purposes, and a central flange on each tube may be provided for transmission of the drive.

Chips of a selected size, or selected sizes, and articles fed into the appropriate end of the top tube of the stack 10 are tumbled and moved continuously along the tube by the thread 15. A fixed chute 16 is provided at the outlet end of the first tube so that the articles are guided into the adjacent inlet end of the next lower tube, and since the latter has an identical thread but is rotated in the opposite direction to the first tube, the articles are then moved along the second tube. A similar chute 16 is provided at the outlet end of each tube 11 connecting it with the inlet end of the next tube of the stack, so that the articles follow a sinuous path through the stack. On emerging from the bottom tube of the stack, the articles are lifted to the top of a second and similar stack 10 by a worm-type elevator 12.

The worm-type elevator 12 comprises a worm element 12a rotating in a vertical cylindrical casing 12b, and the operating surfaces of the element and the casing are coated with abrasive-resistant material.

On discharge from the bottom tube of the second stack 10 the articles are conveyed to the screening unit 13 for separation of the chips and articles. Where articles of different sizes and chips of different sizes have been passed through the tubes 11 together the screening unit 13 serves to separate them into their size groups again.

One preferred arrangement of screening unit shown diagrammatically in Figure 3 comprises four horizontal screening tubes 17 which are formed from mild steel wire mesh coated with rubber or other abrasive-resistant material. A helical beading or thread is bonded to the inside of the tubes, so that on rotation of the screening tubes about their longitudinal axes the mingled articles and chips are carried through the tubes 17 or fall through the mesh on to chutes, down which the separated articles or chips slide to a respective elevator 18 or 19, for example a worm-type elevator

as previously described, for conveyance to a delivery chute. Chips which are separated out are returned to the inlet of the first stack of tubes 11 for recirculation through the machine with the incoming articles.

The articles and chips which are carried through one screening tube 17 are delivered into the next screening tube 17 down a fixed chute 20 for further separation. The first two screening tubes may be of one mesh size and the last two screening tubes may be of a second mesh size. This screening unit is intended to deal with articles of one size and chips of two sizes, or with articles of two sizes and chips of one size. Generally, all the chips will be returned to the inlet to the first stack of tubes 11 by the same conveyor, and a separate delivery conveyor will be provided for each size of article.

The separation is assisted by vibrating the screening tubes, and to this end the screening unit comprises a vibrator 21, which is preferably of the electro-magnetic alternating-current contactless type.

In an alternative arrangement shown in Figure 6, the screening tubes 17 are formed from cylinders lined internally with abrasive resistant material, and a coarse thread 17*a* is formed on the radially inner surface of the lining. The screening apertures 17*b* are provided in the base of the helical channel of the thread.

In the above arrangements the screening unit 13 forms a self-contained unit which is mounted to be readily interchangeable with other screening units of a potential screening range within the general capacity of the machine.

The tank 14 in which the tubes, elevators and screening unit are housed is provided with a water float valve 24 of the normal ball and valve type to control the intake from the mains water supply, and there is provided a hopper 25 containing abrasive compound which is operated by time-cycle solenoid-operated device 26 to discharge additional abrasive compound into the tank at pre-set intervals of time. A water-change valve 27 of the time-cycle solenoid-operated type is also provided to drain off all the water at pre-set time intervals and to allow the water float valve 24 to refill the tank 14 with fresh water and the hopper 25 to recharge the tank with abrasive compound. A circulating pump 28, which is preferably of the self-priming diaphragm type, maintains the water in circulation and prevents settling-out of the abrasive compound.

Inlets to the train of tubes contained in a stack may be provided at different points in the train so that the machine can deal with articles requiring different processing times, say by reason of the finish required, at one and the same time.

Figure 5 illustrates diagrammatically another preferred arrangement, in which the tumbler tubes 11 are of tapering form from their outlets to their inlets, and are rotated about a horizontal axis. The tubes are provided internally with an abrasive resistant liner as in the previously described construction, so that the articles are passed along the tube by the thread assisted by a measure of gravitation, but the helical thread, instead of being uniform, is coarse and deep adjacent the inlet (smaller diameter) end graduating to a finer, shallower thread adjacent the outlet (larger diameter) end. In one construction, for example, the tubes have a taper of 1 in 40, and the thread has a pitch of 1 inch and a depth of ¼ inch at the inlet end, and has a pitch of 1/5th inch and a depth of 1/8th inch at the outlet end of the tube. This arrangement ensures that the entrance to each tube is cleared quickly, and that in the event of overloading of the tubes the articles can ride over the thread.

Instead of being immersed in a bath containing a suspension of abrasive material in water, kerosene, or oil, the tubes may be fed with the suspension through a spray 22 located in the inlet to the top tube of each stack, and in this case seals are provided between each tube 11 and the co-operating chute or chutes 16.

The tubes may be made of aluminium sheet and driving and mounting flanges for the tubes may be in the form of aluminium castings. The tubes may be lined with neoprene, polyvinyl chloride, rubber or other suitable material.

Alternatively the tubes may be made, complete with mounting and driving flanges, from wire-reinforced polyester plastic material. The helical thread is in this case formed integrally with the tubes, no lining being required.

Thus, the tumbling apparatus described provides a completely automatic machine for deburring and polishing articles, which is suitable for remote quality control by closed-circuit television.

BOULT, WADE & TENNANT,
111 & 112, Hatton Garden,
London, E.C.1.
Chartered Patent Agents.

PROVISIONAL SPECIFICATION

No. 39719 A.D. 1956

Improvements in or relating to Tumbling Apparatus

We, ROLLS-ROYCE LIMITED, a British Company, of Nightingale Road, Derby, in the County of Derby, do hereby declare this invention to be described in the following statement:-

This invention relates to tumbling apparatus, that is, to apparatus comprising a container in which articles are placed together with chips of granite or like material and water, kerosene, or oil, containing a suspension of an abrasive compound, the container being then rotated so that the articles tumble and are deburred and polished by the abrasive.

In application No. 18192/56 there are described arrangements in which the tumbling apparatus comprises a rotatable tube, means to feed articles to be deburred or polished into one (or inlet) end of the tube, said tube being constructed or arranged so that by rotation of the tube the articles are caused to travel continuously from the inlet end to the opposite (or outlet) end, and means to receive the articles issuing from the outlet end of the tube.

The present invention relates to further features applicable in such arrangements.

According to one feature of the present invention, the tube is provided internally with baffle means constructed and arranged to reduce the rate of continuous flow of articles through the tube, for a given speed of rotation of the tube, without impeding the continuous tumbling action.

The baffle means may comprise one or more baffle plates which block movement of the articles lengthwise of the tube except through a notch which is formed at the periphery of the plate. When more than one baffle plate is employed, successive plates will be spaced from each other lengthwise of the tube by a minimum distance which is greater than the biggest dimension of the articles being processed.

In a preferred arrangement, the tube tapers from its outlet to its inlet and a plurality of baffle plates, which are spaced apart lengthwise of the tube, are fixed in the tube. Each baffle plate has a notch in its periphery of such size as to permit the passage of the articles therethrough, and the notches of successive baffle plates are displaced angularly from each other; for example successive plates may be arranged with their notches displaced from each other by 180° of rotation of the tube. Each plate is fixed in the tube with its plane sloping at an angle, preferably in the range 10°-20°, to an imaginary plane which is perpendicular to the lengthwise axis of the tube, the arrangement being such that the portions of the plate diametrically opposite the notch are nearest the inlet end of the tube, the portions of the plate adjacent the notch being furthest away from the inlet end of the tube.

In this arrangement the leading edge of the baffle plate, that is, the edge which parts the flow of articles moving on to the edge under gravity, is bent towards the downstream end of the tube and affords a lip which tends to deflect the articles back in an upstream direction. The opposite or trailing edge of the baffle plate is bent over in an upstream direction and tends to deflect the articles upstream and away from the notch.

According to another feature of the invention, the screening apparatus described in Patent Application No. 18192/56 may be modified by providing the screening apertures in the form of longitudinal slots which run substantially the full length of the screening tubes. An increased screening area is thus obtained.

In a preferred arrangement according to this feature of the invention, two tubes are provided with corresponding longitudinal slots and are fitted one within the other, said tubes being rotatable relative to one another, whereby adjustment of the size of slot is obtained. A suitable device for locking the tubes relative to one another is preferably provided. Preferably also two tubes are each lined internally with rubber or similar material.

The features of the present invention will now be described with reference to the accompanying drawings in which:-

Figure 1 shows a perspective view of the general arrangement of a tube with parts thereof broken away to show the baffle plates,

Figure 2 shows an axial section through the tube,

Figure 3 shows a baffle plate, and

Figure 4 illustrates a modification of the arrangement of screening tubes.

Referring to the drawings, the tube of the tumbling apparatus consists of a frusto-conical tube 110 which tapers in diameter from its outlet 110a to its inlet 110b and is supported in bearings (not shown) for rotation about a horizontal axis. The articles to be processed, together with granite chips or the like, a quantity of abrasive material together with oil, kerosene or water containing a corrosion inhibitor, are deposited in the rotating tube at its small diameter end. The tube 110 is lined internally with rubber or other abrasive-resistant material.

As described in Patent Application No. 16192/56, a plurality of such tubes are arranged in series in one or more banks. The mass of articles and chips traverses the tubes in succession and passes to a screening unit (not shown) which separates the articles and chips.

To prevent the mass from traversing the length of the tube 110 too quickly and thus making necessary a considerable length of tube in order to provide an adequate processing time, a series of baffle plates 111 are fixed in the tube 110 at regular intervals along its length, designed and arranged to impede the longitudinal movement of the traversing mass, but to ensure a consistent flow devoid of the possibilities of lodgment with its associated risk of over-processing. The spacing of the baffle plates 111 from each other is sufficient to allow the articles to take up any position, at a point where successive baffle plates 111 are nearest each other, with a clearance from each of the baffle plates.

Each baffle plate 111 in this arrangement consists of a disc made from aluminium or mild steel coated with rubber or other abrasive-resistant material, and the plane of each disc makes an angle α with an imaginary plane perpendicular to the axis of the tube, the value of α being in the range 10^0–20^0, dependent on the size of the articles and on other factors. The action obtained with this sloping arrangement is that the plates 111 tend to throw back the mass in the upstream direction so that a longer processing time is obtained in each tube. In the case of articles weighing less than about 1 oz. each, it is found that the maximum effective value of α is about 10^0, since, if the angle is higher, articles trapped in the corner between the baffle and tube remain lodged despite the rotation of the tube because the gravitational effect is insufficient in comparison with the centrifugal force to dislodge them. For parts weighing more than 1 oz. the maximum effective value of α is 20^0, any increase beyond this value tends to diminish the throwing-back action.

A notch 112 is formed in the periphery of each plate 111, the notch being sufficiently large to allow the articles to pass through it. The sloping arrangement of each baffle plate 111 is such that the notch 112 is nearest the outlet end of the tube and the parts of the plate diametrically opposite the notch are nearest the inlet end of the tube. The notches of successive baffle plates are displaced from each other by 180^0 of rotation of the tube.

Referring now particularly to Figure 3, it can be seen that the leading edge 112a of each baffle plate, that is, the edge of the baffle plate which parts the flow of articles, is bent over towards the downstream end of the tube to form a lip, the action of which is to tend to deflect back in the upstream direction articles which impinge on or near this edge, and that the trailing edge 112b is bent over towards the upstream end of the tube to form a lip so that articles contacting the upstream face of the baffle plate are deflected upstream away from the notch 112.

In one example a rubber-lined frusto-conical tube 5 ft. long has an inlet diameter of 6.00" and an outlet diameter of 7.00", and is connected to be rotated at a peripheral speed of 80 ft. per minute about a horizontal axis. Thus the "fall" along the tube is .100" per foot length of tube. In this case a loose mass is found to move one foot along the tube in 12 seconds.

The inclusion of a series of specially designed baffles was found to increase the traverse time considerably. Thus, employing 3 baffles in each foot length of tube, the time taken for the mass to traverse a foot length was increased to 6 minutes 12 seconds. The number of baffles employed per foot length of tube depends on the size of the articles. For example, if parts 2" long are to be processed, the baffles must be 2" plus a clearance allowance apart at their nearest point, and should thus be, say, 3" apart.

The screening unit (not shown) comprises one or more frusto-conical tubes, each of which is adapted to be rotated about its own axis. This axis will be arranged horizontally so that when the mass of articles and chips is

deposited in the tube at its smaller diameter end, rotation of the tube causes the mass to gravitate towards the opposite end. The screening tubes are provided with screening holes in their peripheries which serve to separate the articles and chips, the size of the screening holes, articles and chips being selected in relation to each other. One or more baffle plates similar to those described above may, according to a feature of the present invention, be fixed in the screening tubes to reduce the rate of flow through these tubes.

In a modification of the screening arrangement described in Patent Application No. 18192/56, the screening apertures may take the form of longitudinal slots which run substantially the full length of the screening tubes so that an increased screening area is obtainable. In the arrangement illustrated in Figure 4 of the drawings the width of the slots is adjustable by using two such slotted tubes 117c, 117d one fitting fairly closely inside the other, and is adjusted by rotating the tubes relative to one another, suitable turning and locking devices being provided. Both of the tubes are lined internally with rubber, and the radial clearance between the outer surface of the inner tube 117c and the inner surface of the outer tube 117d is .010 in one arrangement in which the inner diameter of the inner tube is 7.5".

Six equally-spaced parallel slots are formed in both tubes, and one edge 116 of the inner tube 117c is turned inwardly to guide the mass to the slot. The rubber covering of the edges of the slots may be such as to provide slots having their axes at an angle, for example 35°, to the radial direction. The inturned edge 116 also serves to improve the agitation of the mass.

The outer tube is provided with three mounting and driving flanges which impart rigidity to the composite tube.

Where the screening tube is provided with baffles as hereinbefore described, the parts of the inner tube 117c may be held together and stiffened by the baffles.

BOULT, WADE & TENNANT,

111 & 112, Hatton Garden,
London, E.C.1.
Chartered Patent Agents.

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847,650
1 SHEET
PROVISIONAL SPECIFICATION NO. 39719/56
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Fig.1.

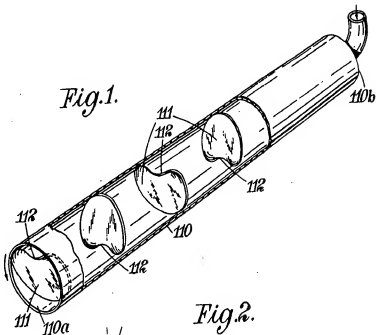


Fig.2.

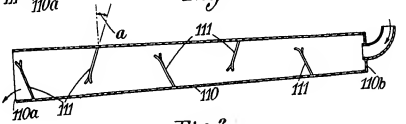


Fig.3.

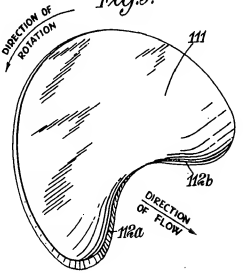
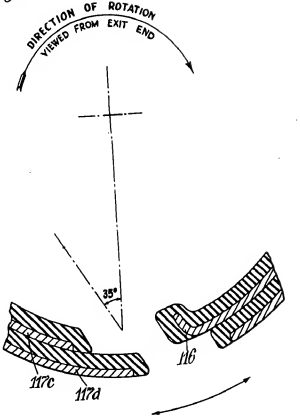


Fig.4.



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2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 and 2

Fig.1.

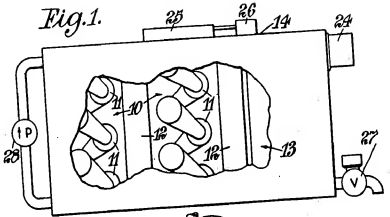

Fig.2.

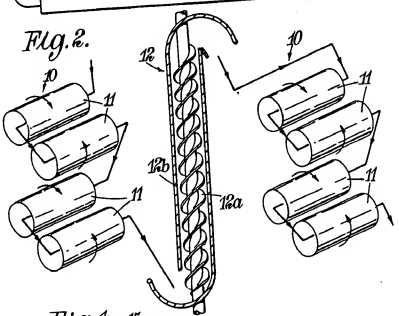

Fig.3.

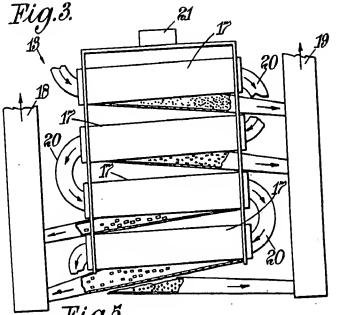

Fig.5.

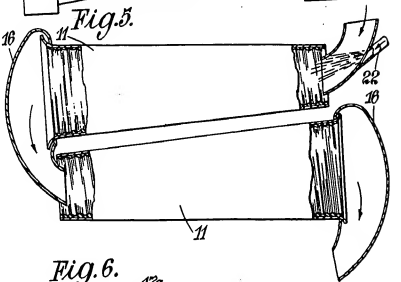

Fig.4.

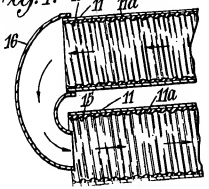

Fig.6.